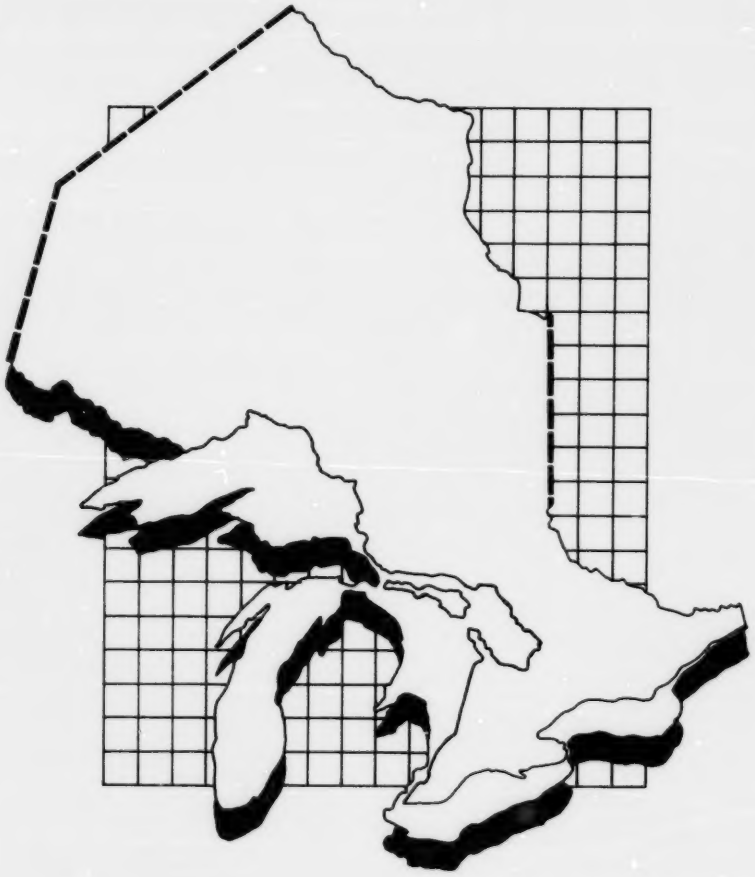
Alternate Energy Supplies and Technologies and their Implications on Land Use Planning



Ontario

Ministry
of
Energy

FINAL REPORT

ON

"ALTERNATE ENERGY SUPPLIES AND TECHNOLOGIES AND THEIR IMPLICATIONS ON LAND USE PLANNING"

PREPARED ON BEHALF

OF: MINISTRY OF ENERGY

BY: ENERPLAN CONSULTANTS LTD.

WITH

THE ECE GROUP

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ABSTRACT

This report examines the most energy-efficient systems and technologies available for the planner of industrial, residential, and commercial developments today. In shows in detail, the amount and nature of the wasted energy now being produced by conventional fuels and systems and then explains the strategies available to use this wasted energy. Cogeneration and district heating are two such strategies for which a strong case is built here. The report deals with existing structures and municipalities and the potential inherent for energy-efficiency in new developments. Efficient land use is the key to utilizing this wasted energy. With proper planning, hospitals and schools, for example, could be heated from previously wasted industrial thermal power. Guidelines for working with regulatory bodies are also set forth.

EXECUTIVE SUMMARY

The planner has a unique responsibility in this energy-conscious age: the responsibility to incorporate in each development under his jurisdiction the most efficient, cost-effective systems for heating and general purpose energy use possible. To do this, he must be continually aware of the developing technologies available for his purposes, and be able to weigh his initial capital costs against future, long-term savings inherent in his proposed systems. Thus, the planner needs to be farsighted enough to be able to project future energy costs of both conventional fuels like oil and natural gas and alternative fuels like methane from waste and to use those fuels as efficiently as possible. In choosing energy systems for his proposed developments, moreover, he must be sensitive to the particular environment being built or designed: his system must be the most suitable one available for the industrial, residential or mixed environment he is planning.

The planner also needs to have a political awareness of the feasibility of his proposals in terms of existing legislation. He must know who will own, sell, and manage the energy the use of which he has so efficiently planned. He needs to know environmental standards and have some feeling for the potential for public acceptance of his proposals.

This report, commissioned by the Ontario Ministry of Energy, takes an in-depth look at the energy choices available to today's planner. It concludes that conventional energy systems such as coal-fired generating plants and electric transmission facilities are inefficient (inherently energy wasteful) compared with alternate technology and systems--specifically cogeneration and district heating--and endeavours to explain in detail how these alternate systems work.

Both the cogeneration and the district heating proposals discussed in this report draw their greatest strength from their ability to productively use energy that would otherwise be wasted. Cogeneration means the generation of electricity and thermal power from one basic source energy. The thermal energy can be used as dry heat for an industrial process or be converted into steam or hot water. Such a dual-purpose process can improve the efficiency of the source energy utilization from about 30 per cent to 85 per cent. The planner is introduced to three principal approaches to cogeneration in this report: central utility plant cogeneration, industrial plant cogeneration and total energy with cogeneration.

District heating is the use of one or more centralized sources of heat to supply thermal energy to a group of buildings. This system has great potential because it can use heat generated by industry to heat hospitals, apartment complexes, and other areas of the community which might not be economically served on their own. All groups of buildings under a single ownership are prime candidates for such a system.

The final pages of this report look specifically at the land use planning principles involved in the energy-efficient proposals discussed in detail in the earlier part of the work. These principles are essential to the viability of the energy proposals. They must work hand-in-hand. Some of these include: contiguous, centralized development; medium and high density residential development; proximity between home and routine services required outside the home; public transit; foodlands preservation.

The planner, then, has a great deal of work ahead of him. Not only must he design and implement energy-efficient land use proposals, but he must be prepared to explain his designs to the governing and regulatory bodies responsible for the areas under development. These pages should serve as a guideline to his future efforts.

CURRENT ENERGY SUPPLY

Electricity

Introduction

Electricity is a community's most convenient energy supply since it does not require storage facilities, does not cause pollution at the consumer end and can be converted at almost 100% efficiency into heat and also at very high efficiencies into mechanical energy.

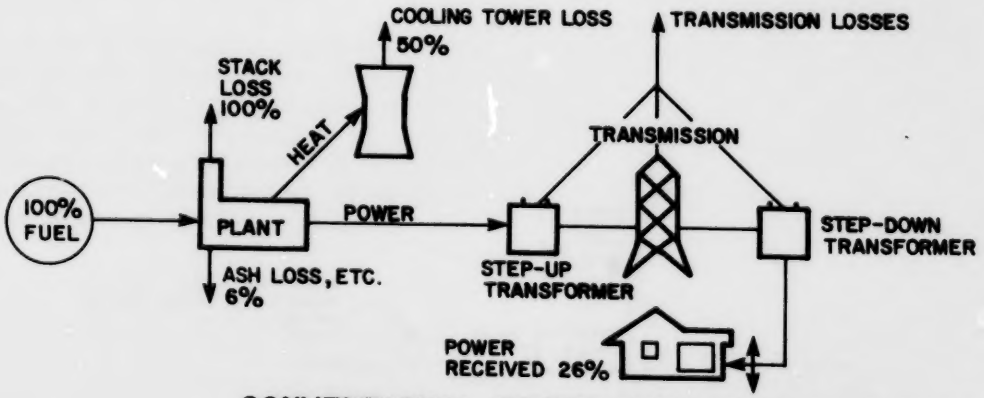
The production of electricity from fossil fuels involves the following chain reaction:

fuel — heat — mechanical energy — electrical energy

This chain reaction is inefficient. In most cases the quantity of heat wasted is much greater than the energy usefully converted into electricity. A large proportion of the heat is lost to the atmosphere either directly as exhaust gas from boilers, gas turbines, gas engines and diesel engines released into the air, or indirectly through the cooling process.

Thus, the actual practical efficiencies of even the most modern steam plants seldom exceed 34-36%. The consumer only receives 26% (34% plant efficiency - 8% transmission losses) of the original energy.

The main schematics of the conventional power generation plant are shown below:



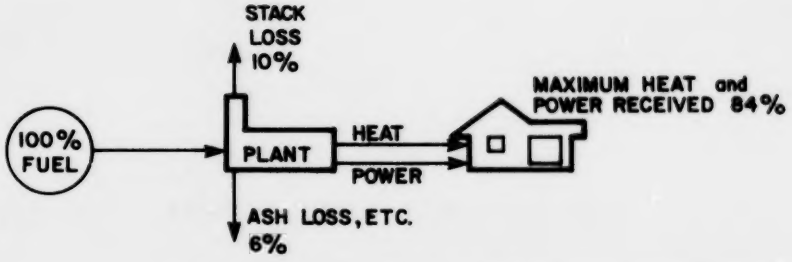
CONVENTIONAL POWER GENERATION · FIGURE 1

In order to reduce the energy waste inherent in conventional utility plants, energy waste in the form of water and steam can be redirected and effectively utilized elsewhere or within the plant itself. This would nearly double thermal efficiency and would reduce primary source fuel consumption by at least one third.

The low efficiency of a conventional power plant can be improved significantly by using the waste heat in flue gases and cooling cycles; or by a cascading process producing electricity whereby lower level heat could be used via upgrading, for the generation of extra electricity, or directly for space heating and other low intensity uses.

Besides conventional central power generation, there exists the "total energy" system, depicted below, which can locally produce both forms of energy, (i.e. electricity and useful heat), as demonstrated by existing systems supplying schools, universities, and hospitals. Relative to conventional power plant efficiency of 3 kw of gross (source) energy to produce 1 kw of net (consumer) energy, this decentralized system only requires 1.2 kw of gross energy to produce 1 kw of net energy.

Since this kind of energy can be produced locally, the Planner can encourage the use of these systems in collaboration with schools, hospitals, private institutions, residential sectors or any other energy 'load zone'. The local Planner can prepare a policy report on the subject of alternative energy supply technologies and systems, which, in turn, could provide the basis for public meetings, and meetings with local utilities, school boards, Chamber of Commerce, and so on.



TOTAL POWER GENERATION - FIGURE 2

MIX OF PRIMARY ENERGY SOURCES IN GENERATING ELECTRIC ENERGY IN ONTARIO

%	1975	1980	1985	1990	Supply
Hydroelectric	48	34	28	24	Indigenous Source almost fully developed
Coal	28	29	22	12	Imported
Residual Oil	1	2	2	2	Imported
Natural Gas	7	1	1	0	Imported
Uranium	16	34	47	62	Indigenous
Total	100	100	100	100	

Hydro Electric

Until 1951, when the R.L. Hearn coal-burning station was put into service, Ontario's electric power system was exclusively based on hydraulic energy.

Since 1975, hydroelectricity's contribution to the total electric energy budget has been reduced substantially and future utilization of this resource, relative to other energy sources, will be diminished.

In fact, by the end of the century, the percentage contribution of hydraulic energy is expected to decline to about 18% of the provincial electricity demand. Ontario Hydro is, however, studying the development of small, as yet undeveloped sites in Ontario.

Coal

Electrical generation has accounted for more than 72% of Canada's coal consumption. The use of coal in generating electricity has doubled since 1965.

Natural Gas

Natural gas burns at an efficiency of 85% in large boilers. However, since it is a most valuable feedstock for the chemical and pharmaceutical industry, its use as primary (power plant) fuel should be restricted.

Oil

Because the supply of residual oil for Ontario's requirements is regarded as reasonably stable for the next 20 years, it is anticipated that oil-fired stations will continue to satisfy the need for peaking power.

Uranium

Because of Ontario Hydro's long term commitment to nuclear power, uranium should continue to be a primary energy source. There is, however, growing public concern for the safety of operations and the safe disposal of spent but radioactive fuel.

There are four operating nuclear generating stations in Ontario: Pickering, Bruce and Douglas Point, and Rolphton, northwest of Ottawa.

Electricity Supply in Ontario

The sources of electricity supply in Ontario have changed over the last 15 years.

An increasing amount of Ontario's electricity is being imported from Quebec, Manitoba and the U.S. (These imports continue for reasons of economics: in certain areas, electricity can be supplied at lower costs by outside utilities.)

FOSSIL FUELS

Introduction

The choice of fuel or fuels for energy systems influences its economic viability and environmental acceptability as can be appreciated below:

Fuel	Advantages	Disadvantages
Gas	. Environmentally most acceptable . Easily transportable . No consumer storage required	. Expensive . Availability (depends on pipeline system)
Oil	. Environmentally acceptable . Relatively easy transport . Easy storage . Small plant size	. Expensive . Availability (politically determined) . Extensive anti-pollution equipment required
Coal	. Inexpensive . Availability	. Transportation by rail or water to urban area . Air pollution control facility required . Large storage area required . Large plant size . Public acceptance in urban area
Refuse	. Relatively inexpensive . Environmentally acceptable . "Renewable" supply . Reduced landfill requirement	. Large plant size . Inconsistency in low heating value . Limited supply . Heavy truck traffic
Biomass	. Relatively inexpensive . Environmentally acceptable . Semi "renewable" resource	. Collection and transportation . Storage and handling . Limited supply . Limited applicability

Ontario's Fossil Fuel Resources

Oil

Ontario accounts for 33% of total Canadian oil consumption. Crude oil supplies from Western Canada account for about 91% of this consumption.

Transportation accounts for close to half of the province's oil consumption. Residential or household users consume 13% while industrial uses, including mining and manufacturing, consume 10%.

Due to government incentives encouraging the use of natural gas over oil, it is anticipated that future oil consumption will decrease in the commercial and residential sectors.

Coal

Ontario produces no coal and depends on the U.S., Western Canada, and the Maritimes for supplies. Ontario's only potential coal resource of reasonable magnitude is the Onakawana lignite deposit in Northern Ontario, with an estimated reserve of about 190 million tonnes.

Ontario accounts for about 51% of total Canadian coal consumption and for virtually all Canadian coal imports.

Natural Gas

Almost all of Ontario's natural gas comes from Western Canada.

The increase in natural gas consumption is attributable to its price advantage and public concern over oil supplies.

1) CONSUMERS GAS COMPANY
2) UNION GAS COMPANY
3) NORTHERN AND CENTRAL GAS CORP. LTD.

FIGURE 8

Ontario's conventional fossil fuel (coal, oil and natural gas) energy supply systems are shown below, with the chain of events involved in their production, preparation and consumer end use.

	COAL	OIL	NATURAL GAS
PRODUCTION	Open Pit Undergound	Well	Well
	Transport	Transport	Transport
PREPARATION	Cleaning Grading Flurrying	Distillation	Cleaning Dewatering
	Transport	Light Medium Heavy Asphalt	Storage
		Transport	Transport
CONSUMER	Unprocessed Separation Regrading Powdering	Storage	Storage
	Combustion	Combustion	Transport
	Heat Coke Ash	Heat	Combustion Heat

Refuse

Every year in Ontario some 6 million tonnes of municipal solid waste are created. Each tonne contains slightly more recoverable energy than a barrel of oil.

SOME MUNICIPAL SOLID WASTE PROJECTS UNDER EVALUATION IN ONTARIO

Project	Waste Quantity (tonnes/year	Energy Product Type	Energy Product Oil Equivalent (m 3 /yr)
Hamilton - Tricil/SWARU	110,000	Steam	19,200
London - Victoria Hospital	70,000	Steam	12,200
	127,000	Steam	22,200
Niagara - Ontario Paper	211,000	Steam/ Electricity	36,900
	586,000	Steam/ Electricity	102,500
North Bay - Nordfibre	60,000	Steam	10,500
Ottawa Carleton - District Heating Project	275,000	Steam/ Electricity	48,000
Owen Sound - Hospital Project	14,000	Steam	2,500
Peel Region	296,000	Steam	52,800
St. Catharines - General Motors Project	56,000	Steam	9,900
Sudbury - Inco Project	96,000	Fuel/Compost	16,800
Toronto - Commissioners St. Project	187,000	Steam	32,700
- District Heat. Incin.	380,000	Steam	66,400
- R.L. Hearn Gen. Station	490,000	Steam/ Electricity	85,700

Biomass

Tree plantations for energy purposes may become common in Ontario. Plantations could be established on farmland that is too wet or stony for conventional agriculture.

From an agricultural perspective, crops such as corn, sugar beets, potatoes, Jerusalem artichokes, and barley grown on poor or underutilized farmland, could be directed to the production of ethanol.

FUTURE ENERGY SUPPLY

Cogeneration

Cogeneration means the generation of electricity and thermal energy from one basic source energy. The thermal energy can be used as dry heat for an industrial process or converted to steam or hot water.

Cogeneration is one of the most powerful potential means to reduce energy consumption. In fact, such dual-purpose processes can significantly improve the efficiency of source energy utilization from approximately 30% to 85%. While steam power plants are rejecting most of the heat content of the fuel they use, buildings and industries are independently burning fuels just to produce low temperature steam for space heating and process uses. Thus, combining these two operations via "cogeneration" would greatly increase the overall efficiency of fuel use.

Cogeneration in a large central power plant can provide district wide space and water heating for commercial and residential buildings, low-temperature process heat for industry, or both. The planner should be aware of these possibilities and their implication on land use configurations (i.e. cogeneration power plants should be located near such energy demand zones).

Though central utility cogeneration to provide industrial steam was often attractive in earlier years (before 1950), few new systems have been developed. Currently, there are several locations in Canada with the proper concentration of industrial steam demand. However, economic (i.e. cost of accommodating cogeneration equipment) and regulatory (i.e. who will own, sell and manage energy) constraints have essentially hindered new cogeneration programs.

Potential energy savings from cogeneration have been insufficient to offset the capital, operating, and maintenance costs of these systems. However, as fuel costs increase, the economic benefits of central station cogeneration will also increase.

There are three principal approaches to cogeneration:

1. Central utility plant cogeneration,
2. Industrial plan cogeneration and
3. Total energy with cogeneration.

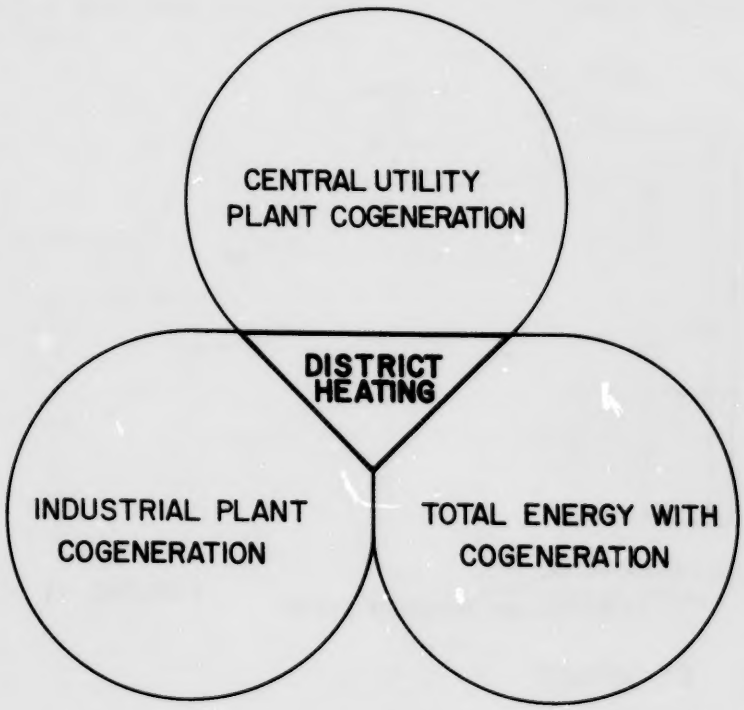


FIGURE 9

ELECTRICAL POWER PLANT COGENERATION

Single Cycle Systems

Single cycle systems, such as the combustion turbines (figure 10), diesel, and gasoline engines are all used for power generation.

In these systems, fuel combustion occurs within the turbine or engine, and the pressures created are converted directly to mechanical work to turn the generator and create electricity.

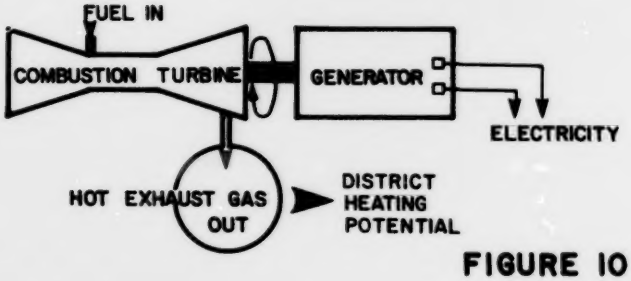


FIGURE 10

In practice, the internal combustion devices typically exhaust their combustion gases at such high temperatures that much of the input energy passes through unused.

In fact, when steam is employed to generate electricity in a modern, high-pressure, high-temperature, single purpose plant, only 38% of the fuel's combustion heat is converted to electricity.

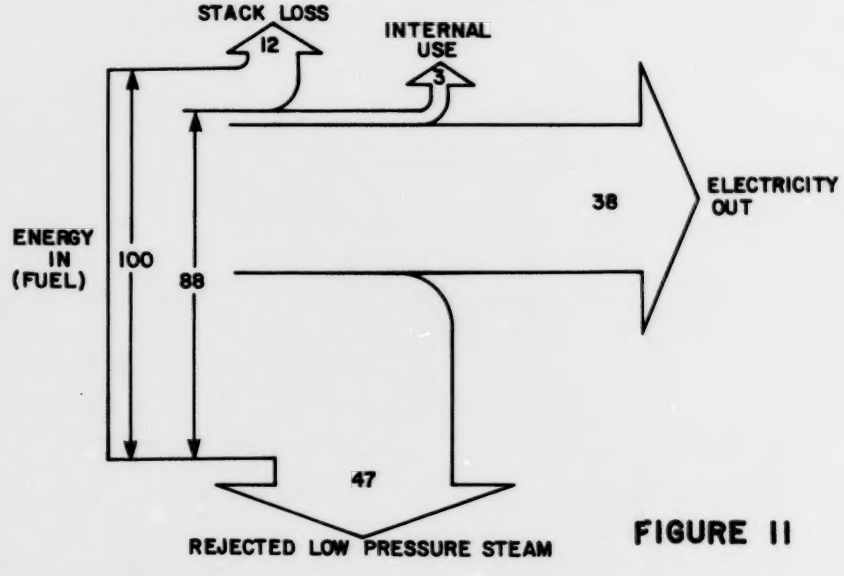


FIGURE 11

Combined-cycle Cogeneration

The combined-cycle cogeneration systems have been designed to achieve more efficient fuel use.

In these systems fuel is burned in a combustion turbine coupled to a generator, and the exhaust gases are used to heat a boiler and produce steam useful for the additional generation of electric power or for use in a district heating system.

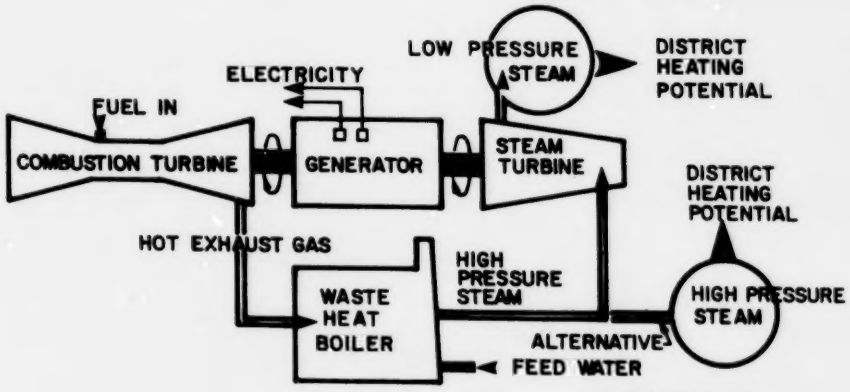


FIGURE 12

A combined cycle cogeneration system using a combustion turbine and a waste heat boiler produces 30% electricity and 47% steam for a total plant efficiency of 77%.

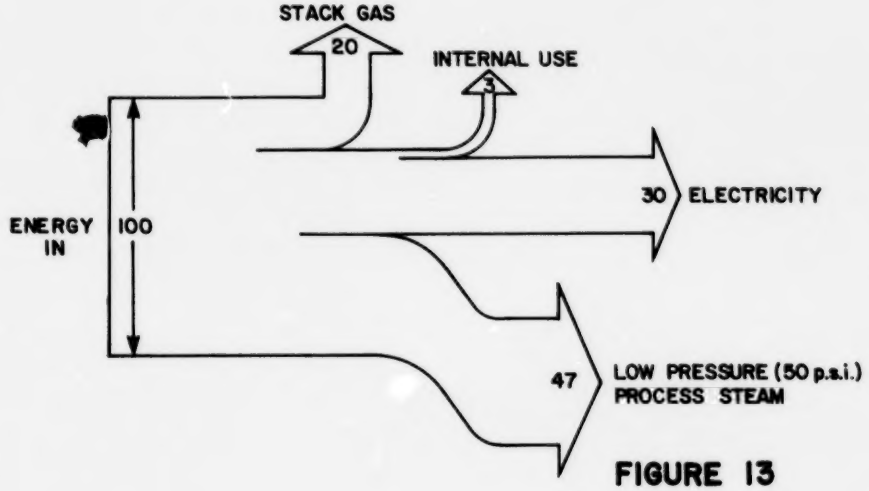


FIGURE 13

Steam Turbine Cogeneration System

By far the most common power source for cogeneration operation is the steam turbine, which uses the energy present in a flow of high pressure steam to provide the mechanical power needed to turn the rotor of a generator. The steam is produced by burning fossil fuels as shown below:

A large part of the potential energy is lost in the cooling water used to condense the steam at the end of the cycle. This heat, upgraded from 110°F to useful temperatures of 160° to 250°F by cascading, are useful for district heating, greenhouse heating, etc. The opportunities for utilizing this waste heat should be investigated by the planner.

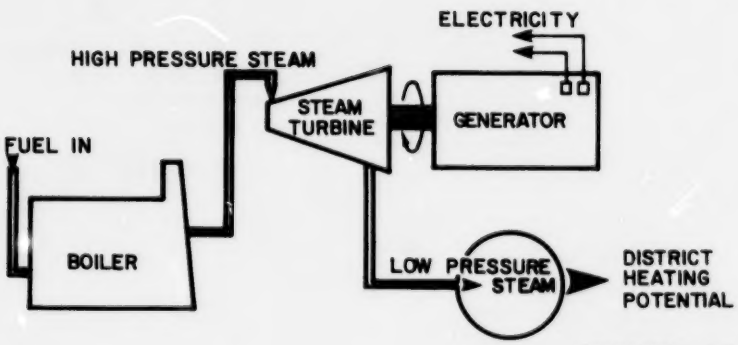


FIGURE 14

A basic steam turbine cogeneration system produces 15 units of electricity for each 70 units of steam.

The low relative amount of electricity to steam (i.e. 15/70) is noteworthy.

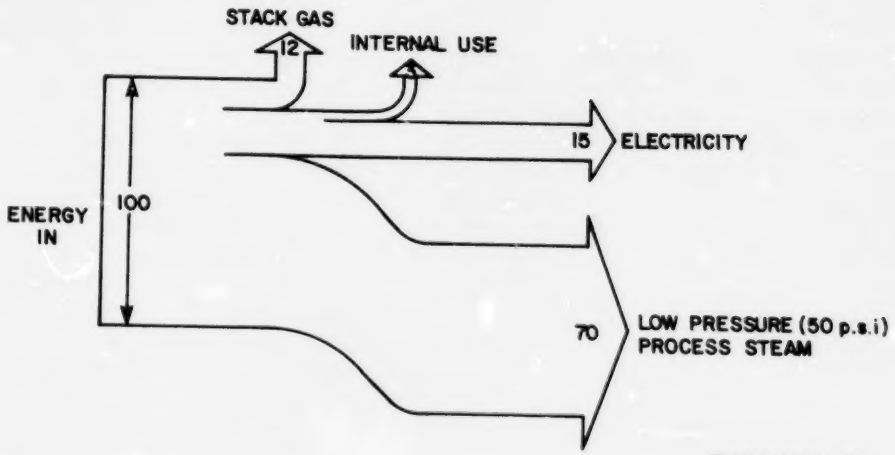


FIGURE 15

INDUSTRIAL PLANT COGENERATION

For many plants in a few major industries like aluminum, paper, chemicals, petroleum and other energy intensive industries (which use large amounts of both electricity and steam), energy economics have consistently favoured cogeneration.

The planner should therefore identify these industries (see page 43) and encourage the development of energy demand zones (i.e. areas with a concentrated demand for the external supply of energy) around them since the lower level energy could be used for district heating systems.

Figure 16 illustrates a cogeneration system typically found in the industrial sector. The lower level heat could be useful for district heating purposes.

Cogeneration is presently favoured where an industrial plant can satisfy its needs for electricity and steam with a simple, basic boiler and steam turbine system. Such plants will use 65 to 80% of their energy demand as low pressure steam, and the remaining 20 to 35% as electricity.

For example, these conditions are found in many paper plants, and the pulp and paper industry is a leader in industrial cogeneration. Approximately 30% of the electricity used in the pulp and paper industry is cogenerated with the steam production in paper mills.

At the industrial level, the principle of cogeneration has been applied to industry's high energy consumers. Energy conservation by such industries may make some of this steam available for district heating, especially if these industries burn their waste in special incinerators equipped with waste heat extraction boilers.

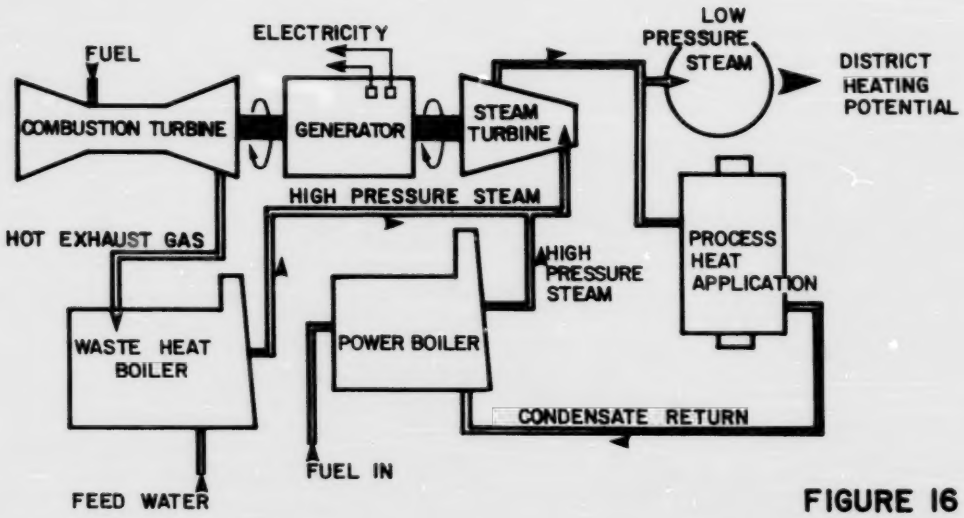


FIGURE 16

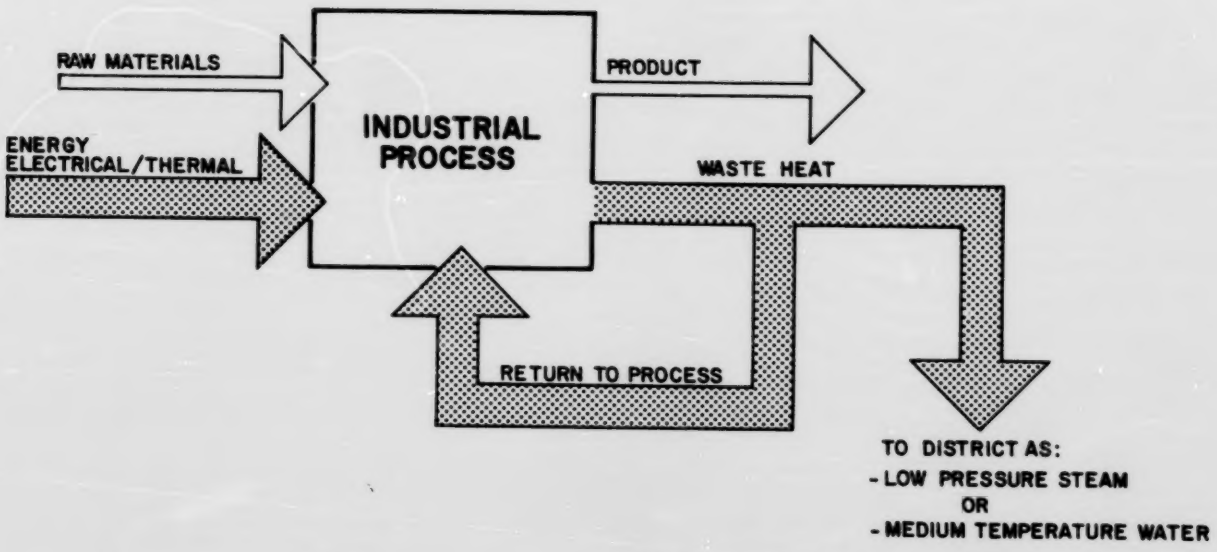
TOTAL ENERGY COGENERATION SYSTEMS

These smaller, dual-purpose systems could provide both electricity and heat to high load intensity complexes. They could effectively be combined with central power sources to supply peak thermal requirements as well as the base load.

In general, however, these smaller systems are costly (50 to 100% greater than those for large industrial or central station units).

ENERGY CASCADING

Energy cascading involves using all potential energy from any source at different levels of intensity.



ENERGY CASCADING · FIGURE 17

With the rising cost of energy, cascaded systems are becoming economically more attractive. They may represent the difference between profit and loss to industry and can result in considerable savings to customers of a district heating system.

Energy Cascading in the Consumer and Industrial Sectors

Several examples of energy cascading in the consumer and industrial sectors are presented next to illustrate a variety of applications and the potential for energy conservation.

Consumer

Automobile engine: Most of us are very familiar with the automobile. Its engine combines a number of functions, the primary one being traction. It also drives the generator, fan, hydraulic pump, air conditioner and other accessories. In addition, it also provides the heat for the car by circulating the cooling water.

However, because the automobile engine works at an efficiency of 35% or 50%, most of the potential energy is lost. As well, accessories such as the generator, the hydraulic pump and the air conditioner lower the energy available for traction power. The only cycle-improving accessory is the heating system which uses waste heat normally lost to the atmosphere. The heating system demonstrates the use of energy cascading within the automobile engine.

Heat pump: The heat pump takes heat energy from a low temperature source, uses mechanical work to upgrade the temperature, and rejects both the heat from the low temperature source and the mechanical work to the load.

The heat pump consists of two units: an outdoor one which absorbs heat from the atmosphere and an indoor unit which releases this thermal energy to the building's interior.

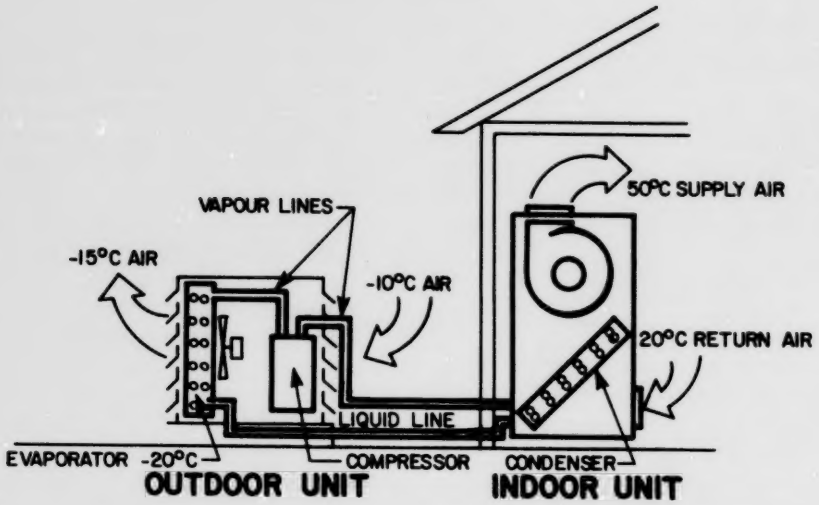


FIGURE 18

Generally, heat is transferred by means of a working fluid (e.g. freon). This fluid is piped cold from the interior of a building to the outdoor unit where it goes from a liquid to a gas in an evaporator. As a result, the liquid absorbs heat from the ambient air. A compressor circulates the gas back to the building where it is condensed and changes back to a liquid, releasing its heat energy and warming the interior air.

Industry

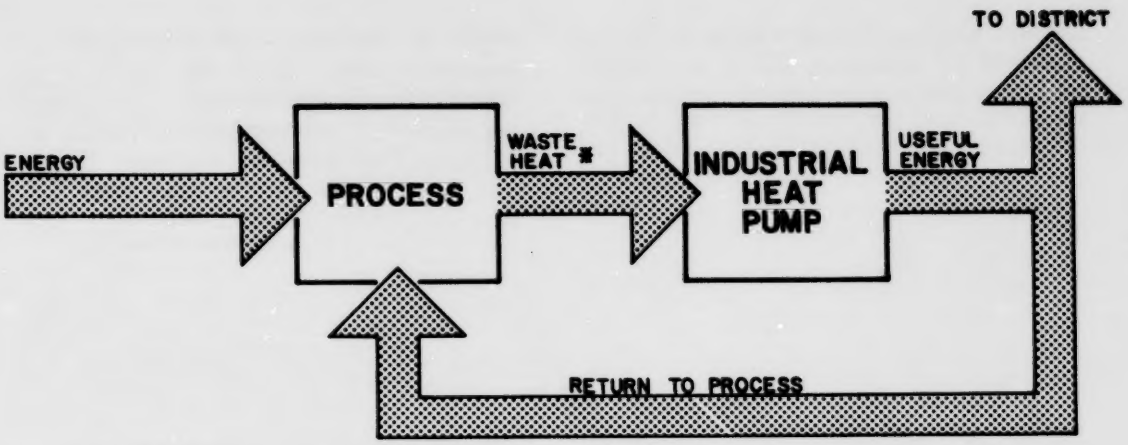
Energy cascading can play an important role in the industrial sector utilizing large amounts of waste heat.

In the past, the absence of a national energy policy provided no co-ordination between utility and the industrial sector.

Energy management was rarely considered, and therefore industrial energy cascading was never truly realized.

Today the planner is in a position to develop an energy management strategy between utility and industry. By co-ordinating the energy policies of both groups, the planner can eliminate some of the resistance to industrial heat cascading.

Industrial Heat Pumps: The great demand for relatively low level thermal energy makes industrial heat pumps potentially attractive. But relatively high costs of capital equipment and energy have made heat pumps uneconomic in the past. However, the changing costs and availability of fuels are beginning to make the industrial heat pump a more viable concept.



* ENERGY INTENSITY TOO LOW FOR PROCESS.

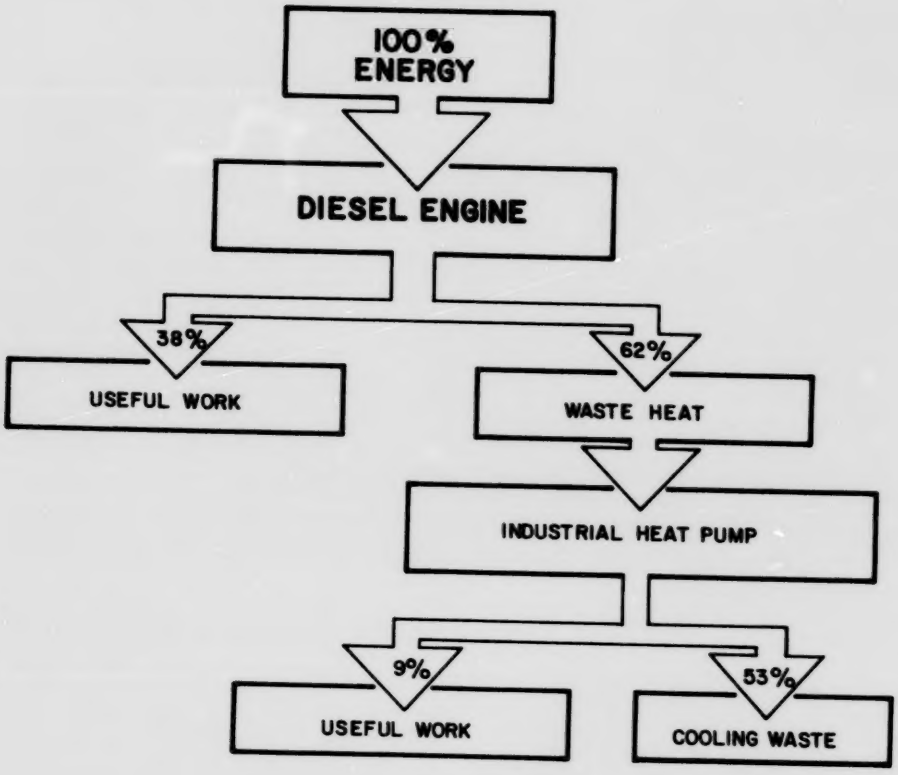
INDUSTRIAL HEAT PUMP · FIGURE 19

The unique feature of this heat pump is that it uses waste heat to vaporize water. The resulting steam drives a turbine and the exhausted steam can be added to the plant's supply of process steam or can be used for district heating. In addition the turbine drives a vapour compressor which enables the extraction of low intensity heat from the contaminated process steam and makes it available as cooling water for low energy intensity applications.

Such a cascaded system has a high measure of performance. Sources such as the food, chemical and drug industries often require such systems. As a result, the Planner should be aware of this in order to take effective advantage of land use planning around these sources of waste heat.

Diesel Engine: Any system that converts the chemical energy in a fuel into heat and work results in an energy loss.

Some of the losses are impossible to recover due to the laws of thermodynamics; others are not physically or economically feasible to recover, but some of the heat losses can be used as can be seen with the process below which illustrates the energy flow in a large diesel engine.



ENERGY FLOW IN DIESEL ENGINE · FIGURE 20

Of the total energy content of the diesel fuel entering the engine, roughly 38% is delivered in the form of useful work.

Of the remaining 62%, 9% can be recovered for useful process application while the excess 53% (waste) can be effectively utilized as a low level heat source for district heating application.

SOLID WASTE AS FUEL

Solid waste, generated by the human population, can be used as a source of energy, and when fully utilized will allow a significant (7% of national demand) replacement of fossil fuels. For instance, the combustible portion of a community's solid waste can provide up to 90% of the thermal energy and up to 35% of the electricity for its hospital. Of this waste, 20% by volume and 10% by weight remains in the form of ash, suitable for road bed base, fertilizer base or landfill when screened from surface water.

The processing of solid waste typically involves incinerators which usually have a constant rate of feed and a fairly constant ouput from their waste heat recovery boilers. Careful matching of this production and the yearly hour by hour load of potential users will enable proper choice of producers and receiver(s). Ideally such a plant would serve the constant base load year round, topped only when required by other generators using prime fuels to satisfy seasonal peak demands.

Through lack of landfill sites, dense populations, high energy rates, and lack of indigenous fossil fuels, the proper technique of burning waste and extracting energy has been developed throughout Europe for thirty years and is now also widely used in Japan. The incinerator manufacturers are all represented in the U.S.A. and in Canada. Incinerators, under active development for small and medium loads, are finally becoming an economic alternative to landfill sites.

As a source of energy in Canada, solid waste is expected to grow for several reasons including:

- The apparent lack of future landfill sites
- The shortage of fossil fuels and the need to conserve them for chemical processes
- The rising costs of fossil fuels
- The improved performance of incinerator technology

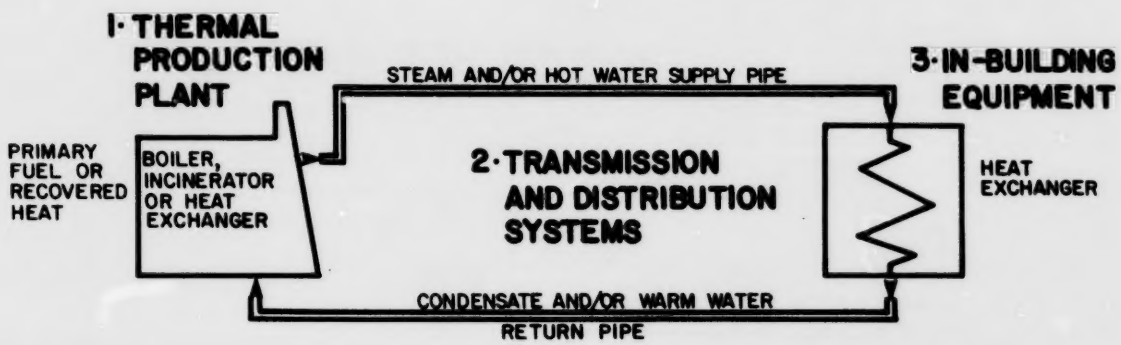
DISTRICT HEATING

Introduction

District heating can be defined as the use of one or more centralized sources of heat to supply thermal energy to a group of buildings. Heat sources may include cogenerating power plants, municipal incinerators with heat recovery capabilities and industrial waste heat sources (i.e. cascade energy).

There are three major components to a district heating system:

The first component is the supply of thermal energy to the system, whether generated by primary fuels or recovered heat. The second component is the transmission/distribution system which transfers energy from source to user. The heat is usually piped out as hot water or steam.


1·THERMAL PRODUCTION PLANT
STEAM AND/OR HOT WATER SUPPLY PIPE
3·IN-BUILDING EQUIPMENT
PRIMARY FUEL OR RECOVERED HEAT
BOILER, INCINERATOR OR HEAT EXCHANGER
2·TRANSMISSION AND DISTRIBUTION SYSTEMS
HEAT EXCHANGER
CONDENSATE AND/OR WARM WATER RETURN PIPE

DISTRICT HEATING·FIGURE 21

The third component involves the in-building equipment which would be required at the consumer end. Typically, the equipment includes: a heat exchanger and a storage tank.

The technical factors involved in the evaluation of district heating as per each of these components include:

THERMAL PRODUCTION PLANT

Type of boilers:

- conventional
- fluidized bed
- heat recovery

Type of fuel:

- coal
- oil
- gas
- refuse
- wood
- nuclear

Fuel delivery and storage
Ash disposal
System load and duration
Boiler efficiency
Heat exchangers (hot water)

Retrofit alternatives:

- extraction points
- back-pressure turbines
- boiler

Sitting and land use
System losses
System expansion alternatives
Load factor - electric and heat
Community impacts

TRANSMISSION AND DISTRIBUTION SYSTEMS

Line losses
Systems Load
Send-out temperature
Return temperature
System pressure
Water quality
Pumping stations
Line size and expansion potential

IN-BUILDING EQUIPMENT

Enthalpy drop through buildings

Building design:

- thermal efficiency
- retrofit or new heat exchangers

Number and type of heat exchangers:

- heating
- hot tap water
- cooling

Process use

The application of all three components at the community level can be appreciated below.

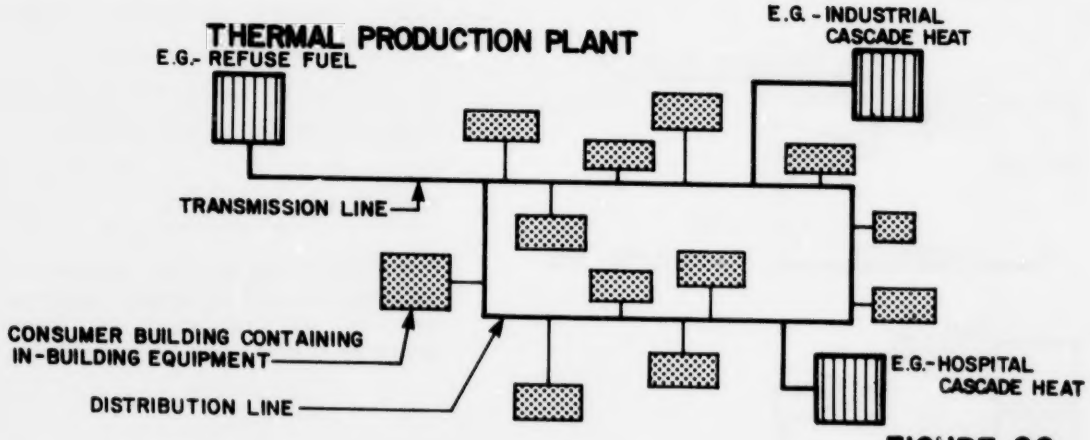


FIGURE 22

DISTRICT HEATING ENERGY SUPPLY TECHNOLOGY

There are at least five ways to extract waste heat from an industrial process for use in a district heating system.

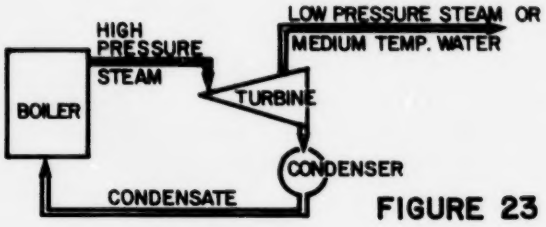


FIGURE 23

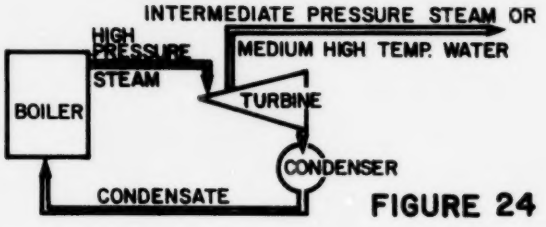


FIGURE 24

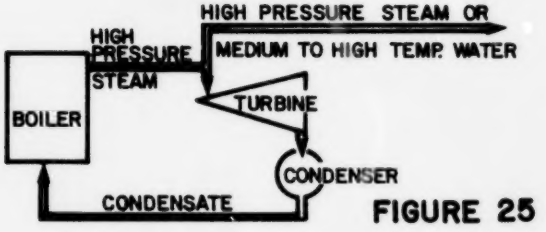


FIGURE 25

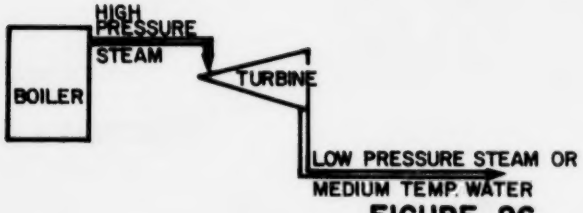


FIGURE 26

A. Low Pressure Extraction From Condensing Turbine

Because the temperatures and pressures required for district heating are low, the best point for extraction is on the low pressure side of the turbine.

B. High Pressure Extraction From Condensing Turbine

Can extract from higher pressure side. However, this will cause a greater loss of electrical production than low pressure extraction.

C. High Pressure Extraction From Main Steam Line

Steam can be extracted from the main steam line to the turbine.

D. Back-Pressure Turbine

For new co-generation plants, or existing plants in which turbines are to be replaced, a back pressure turbine can be installed.

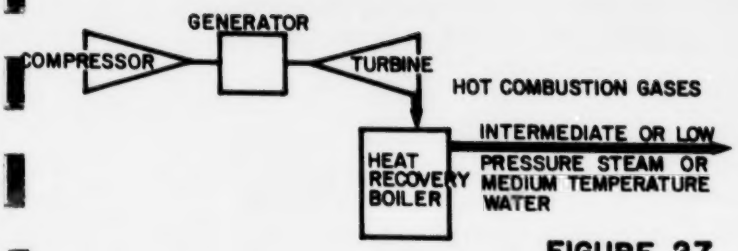


FIGURE 27

E. Combustion Turbine with Heat Recovery Boiler

Because these are considered peaking units on most electrical systems, they cannot serve as base-load units for district heating.

FUEL CHOICE FOR DISTRICT HEATING BOILERS

Because of the relatively small size required for district heating boilers at this time, oil and gas-fired package boilers are readily available and can be quickly installed. The use of coal on the other hand, presents an air pollution problem, logistics (fuel delivery, handling and ash disposal), and space problem in urban and suburban locations which are most advantageous for district heating.

Another option available is the refuse boiler. When applied to district heating, it offers the advantages of being located where most of the refuse is generated, thus reducing transportation costs of the refuse.

DISTRICT HEATING DISTRIBUTION

Distribution makes use of either steam or hot water. The latter has many advantages such as lower corrosion, lower systems losses, lower maintenance, independence of terrain, infinite distribution net extensions, lower distribution energy demand and smaller line losses. This medium is predominant in Europe and is gaining increasing acceptance in North America, especially through its usefulness at low thermal levels where the comparable steam pressure would not permit distribution of steam over any conceivable distances.

The thermal energy (steam/hot water) for district heating distribution can be generated in order of preference by:

1. A utility power plant with cogeneration of heat
2. An industrial cascade plant
3. An industrial cogeneration plant with excess thermal capacity
4. An industrial steam plant
5. A heating plant with cogeneration of electricity
6. A conventional heating plant

The possibilities and combinations seem endless. It must be realized that the advantages of higher thermal efficiency in a conventional central heating plant may be greatly reduced through distribution losses. Therefore, one of the key elements to successful district heating will be minimal distribution distance.

A comparison of the main characteristics of steam and hot water heating systems is shown.

Description	Steam	Hot Water
Temperature (^{o}F)	300 - 500	150 - 250
Pressure (psi)	150 - 500	100 - 150
Main Pipes	1	2
Pumps	No	Yes
Steam Traps	Yes	No
Metering	Difficult	Easy
User Investment	Low	Moderate
Transport Distance (max)	3 miles	70 miles*
Type of Pipe	Steel	Steel, hydrocarbonation, fiberglass, etc.

* Depending on intensity of heat and density of end-use.

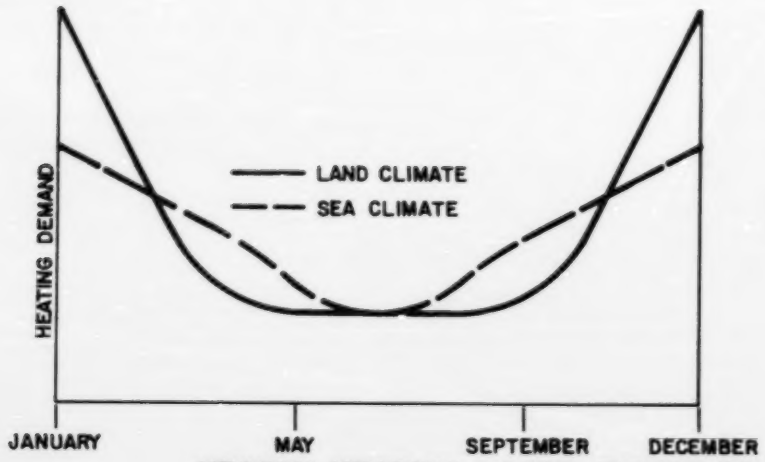
LOAD CHARACTERISTICS FOR DISTRICT HEATING APPLICATION

In Canada, a relatively low heating base load exists in spring, summer and fall, consisting of domestic hot water loads in all buildings and process loads for industry and hospitals. During the heating season, large but varying loads develop, especially in 'land' climates.

Thus, for heating loads, a district heating system would preferably contain as many industries and hospitals as possible for an optimum yearly load line.

The high load would ideally be covered by low cost waste heat from utilities, industries or refuse fed plants, topped up only as required in the heating season by higher grade energy.

There may be cases where steam from waste energy is available during the summer. In such cases the possibility of using this excess energy for cooling should be investigated, even where steam cooling is less energy efficient than electric cooling.



YEARLY HEATING LOADS · FIGURE 28

RANGE OF APPLICATION

The range of application is virtually unlimited, but is highly dependent upon the number and mix of customers and generators in the service area. In general, thermal sources should be located near the potential heating service area(s). This condition will reduce both the costs of the thermal transmission system and the system's heat losses.

Presently, due to a low energy load density and the expense of a distribution system, conventional single family homes cannot be served economically by district heating. However, with high-rise apartments, approximately 100 units and more, there is a clear economic advantage for district heating. Commercial areas, such as central business districts, malls and shopping centres represent viable district heating and cooling loads.

Other excellent energy loads for district heating include institutional buildings such as hospitals, government offices and schools. In fact all groups of buildings under single ownership should be considered for the system.

Industrial applications of district heating range from the small job shop through large industrial complexes which could support their own cogeneration facility. As well, the large industrial complex should not be overlooked.

In reality, a mix of classes (i.e. residential, commercial, institutional) occurs, which can allow the district heating system to serve areas of the community that could not be economically served on their own. Areas to be served should have high thermal load densities.

Thermal Load Density

Type of Area	MW/km^2	10^6 Btu/hr/acre	Desirability for District Heating
Downtown; high rises	70	0.97	Very Favourable
Downtown; multi-storied	50-70	0.70-0.97	Favourable
City core; commercial buildings and multi-family apartment buildings	20-50	0.28-0.70	Possible
Residential; two-family houses	12-20	0.17-0.28	Questionable
Single-family	12	0.17	Not possible

From the Planner's perspective, district heating is most adaptable to types of urban pattern which are uniformly dense and with the greatest integration. Thus, district heating could be used as an incentive or commitment to future patterns of land use.

Economics of District Heating

Any study on the economical desirability and the financial viability of a district heating system must take into account viewpoints from producer, consumer and community.

The producer will require a guaranteed consumption at a guaranteed price to his advantage. A dedicated community owned system may sell energy at cost, while a utility or industry would require a profit.

The mix of plants serving the district heating system will be determined by the number and type available to retrofit and the annual load dynamics for the system. The optimum economic advantage for retrofitting existing plants can be obtained by balancing the electrical and heat output.

The consumer will want a 'guaranteed' delivery (Ontario Hydro does not provide this), at a price no higher than for any other means at this disposal.

The commitment of the user to the district heating system is probably the most important economic parameter. Since the cost of piping is the largest cost item for the system, total participation by all potential users in the service area is necessary to realize the optimum economic advantage.

The community will want minimum nuisance (pollution) and guaranteed long range availability with a reasonable return on any invested capital.

District Heating Capital Costs For New Communities (1976)*

Population	Central Plant	Distribution Piping	1976 Consumers Equipment	Total
20,000	$8,311,000.	$15,417,000.	$6,551,000.	$30,279,000.
10,000	4,478,000.	7,149,000.	3,280,000.	14,907,000.
2,500	1,883,000.	1,423,000.	821,000.	4,127,000.

District Heating Capital Costs - Retrofitted (1976)

Population	Central Plant	Distribution Piping	1976 Consumers Equipment	Total
20,000	$7,666,000.	$33,802,000.	$7,791,000.	$49,259,000.
10,000	4,000,000.	15,351,000.	3,986,000.	23,337,000.
2,500	1,973,000.	3,865,000.	994,000.	6,832,000.

* District Heating For Small Communities; Acres Shawinigan Ltd.; for Department of Energy, Mines and Resources (Canada); Ottawa; 1977; Page 37.

In general, the Federal Government has concluded that there is an economic case in favour of district heating for new communities as small as 2,300 people incorporating an industrial component or 4,500 people for purely residential communities.

Retrofitting district heating to existing communities is considerably more expensive and a very high percentage of the potential heating load must be converted to the district heating system to make the scheme economically viable.

Economic Evaluation of District Heating Systems

A district heating system in a new development may involve savings for the central plant due to lower unit costs and diversity of loads, but for existing buildings conversion costs to the district system require additional expense.

Costs will be incurred in converting a thermal generating plant to cogeneration.

These initial capital expenditures are offset by savings attributable to increased efficiency, lower cost of fuel, revenues from electrical generation and recovery of materials from refuse, reduced maintenance costs and reduced insurance costs. Whether these potential savings are realized and can recover the initial cost differences is the objective of an evaluation.

In such an evaluation....

- the total cost to the user for district heating must be compared with the cost of conventional heating systems to determine if district heating is economically competitive.

- the district heating system must be economically competitive with existing fuels.

In assessing the economic feasibility of district heating the planner should consider:

- capital expenditures required to establish a district heating system including:
  - ..... retrofit of industrial process (i.e. thermal generation plant) to redirect waste heat
  - ..... distribution/transmission system
  - ..... consumer end use equipment
- annual expenses incurred in the operation and maintenance of a district heating system
- the cost per unit of energy of district heating

Planning District Heating Systems

The successful implementation of district heating is highly dependent upon the planner's ability to recognize potential energy sources within the local community.

These sources, typical to most communities (see Figure 29) may include:

Hospitals: These institutions typically generate substantial quantities of waste heat as low pressure steam which could be used by the community (i.e. mixed residential area) for district heating purposes

Industrial Sector: Waste heat (usually low pressure steam or medium temperature water) from the industrial sector (see industrial heat loss summary below) could be cascaded down to a district heating network potentially satisfying some of the energy needs of adjacent industrial uses or nearby commercial and residential land uses.

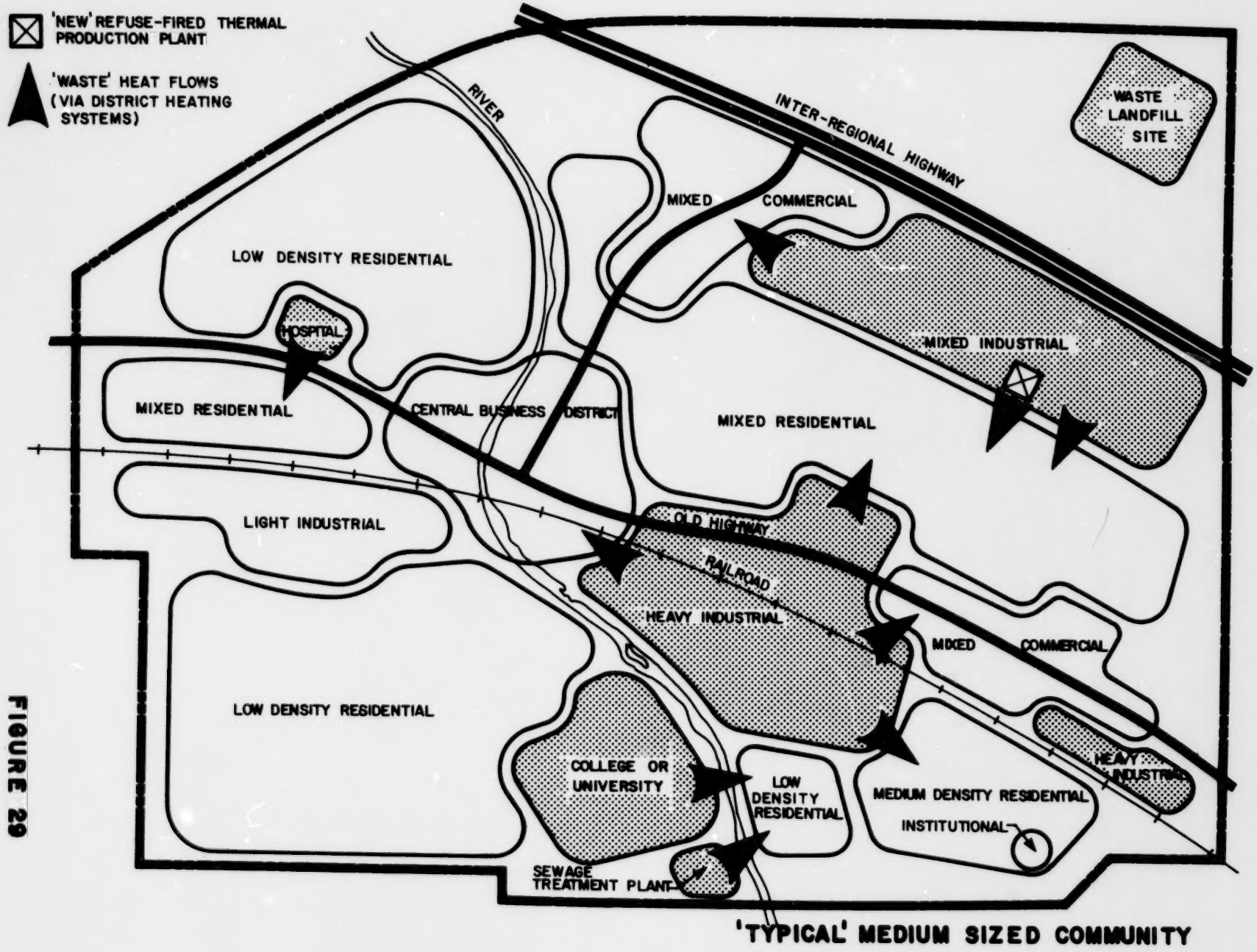

'NEW' REFUSE-FIRED THERMAL PRODUCTION PLANT
'WASTE' HEAT FLOWS (VIA DISTRICT HEATING SYSTEMS)
RIVER
INTER-REGIONAL HIGHWAY
WASTE LANDFILL SITE
MIXED COMMERCIAL
LOW DENSITY RESIDENTIAL
HOSPITAL
MIXED INDUSTRIAL
MIXED RESIDENTIAL
CENTRAL BUSINESS DISTRICT
MIXED RESIDENTIAL
LIGHT INDUSTRIAL
OLD HIGHWAY
RAILROAD
HEAVY INDUSTRIAL
MIXED COMMERCIAL
LOW DENSITY RESIDENTIAL
COLLEGE OR UNIVERSITY
LOW DENSITY RESIDENTIAL
MEDIUM DENSITY RESIDENTIAL
INSTITUTIONAL
HEAVY INDUSTRIAL
SEWAGE TREATMENT PLANT
'TYPICAL' MEDIUM SIZED COMMUNITY

FIGURE 29

Industrial Heat Loss Summary

Industry*	Steam Loss 10^9 BTU/yr	Steam Median Temp. °F	Water Loss 10^9 BTU/yr	Water Median Temp. °F
Paper	4,401	260	1,717	93
Aluminum	3,109	185	68	98
Refined Petroleum	4,582	185	4,257	95
Pulp	2,226	215	1,297	95
Industrial Chemicals	408	210	1,113	110
Sawmills	597	530	195	200
Cement	960	420	44	84
Steel	334	1,210	220	104
Canned Foods	34	220	6	83
Frozen Foods	280	170	10	79
Dried Foods	372	165		
Meat	71	105	52	105
Beverages	318	105	38	75
Glass	230	615	42	85
Dairy	14	195	57	115
Textiles	16	400	88	177

* This information is based on an industrial heat loss survey and applies to single plant operations within each industry.

Institutional Block: The local college or university sometimes satisfies its own energy requirements with an on site 'total energy system' supplying both electricity and useful heat. The extended use of this system to serve outside areas could be realized in an effort to maximize the utilization of such systems.

Solid/Liquid Waste: The sewage treatment plant and waste landfill site, through their respective processes, both generate methane gas, a potentially useful fuel which could assist in satisfying some of the energy requirements of nearby developed areas. As well, solid refuse from the community could be used as fuel in a nearby thermal production plant.

COMMUNITY ENERGY LOADS

The energy consumption pattern of a "typical" municipality is largely dependent upon the following four sectors: residential, commercial, industrial and transportation.*

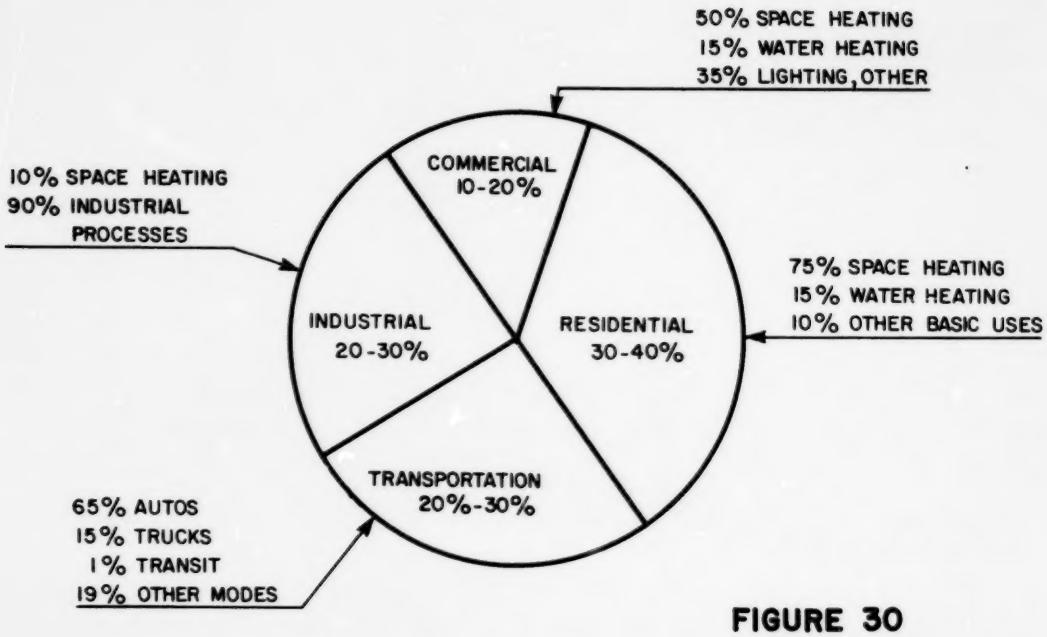


FIGURE 30

* Energy Conservation and The Municipal Planner; Reg Lang and Audrey Armour; York University; (for) Energy Mines and Resources; Building Lines; February, 1980; Page 53.

Residential Energy Load

Space heating demands account for the largest proportion of energy use in the home, whereas air conditioning and miscellaneous electric appliances consume relatively small amounts.

The high consumption of energy in the residential sector comes mostly from heat losses as a result of infiltration through cracks around doors, windows and the basement creates about 50% of the space heating demands; direct loss through windows, walls, floors and ceilings accounts for the other 50%.

Ceiling heat gain in the summer time is responsible for most of the air conditioning demand.

The energy load of a typical 'residential' building is affected by the following energy flow factors:

- Natural and forced ventilation
- Solar heat gain
- Wind-induced infiltration
- Conduction, and heat loss from non-space energy conditioning

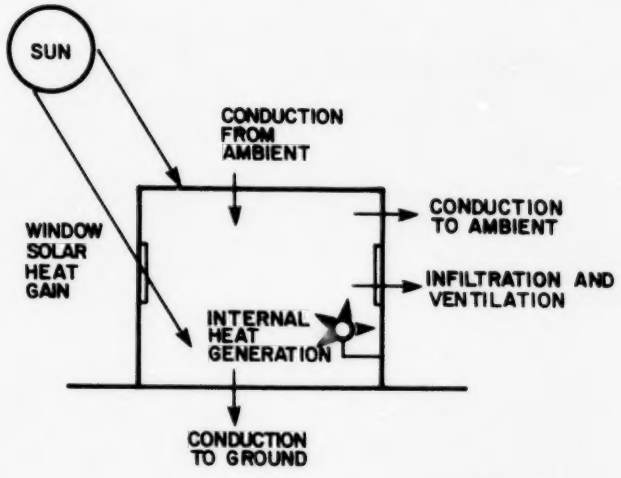


FIGURE 31

Industrial Energy Loads

The consumption of energy vis-a-vis the different industry types depends on their respective demands. For instance:

Industry	Average Steam Demand (1,000 lb/hr)	Average Electric Demand (MWe)	Process Steam Temperature (°F)	Process Steam Pressure (Psig)
Chemical	700	40	360	150
Petroleum	1,000	60	360	150
Paper/Pulp	1,000	50	360	150
Textiles	150	6	360	150
Food	100	4	280	50

Heat Losses in the Industrial Sector: Approximately two-thirds of the identified heat losses are in the form of Gas Streams and 28% of the losses are in the form of Water Streams.

The majority of industrial heat losses occur at low temperatures (good for district heating) and only relatively few cases of significant quantities of high-temperature losses exist.

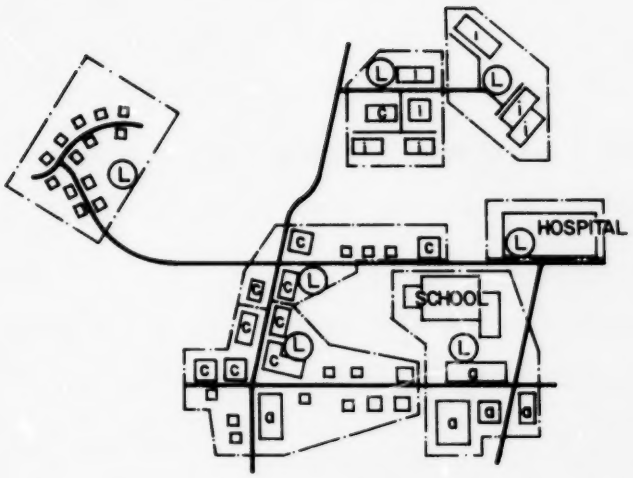
Planner's Perspective

Once individual building energy loads have been determined, a Planner must then identify the community's energy load centres.

A load centre is defined as the centre point of an aggregate of building types.

Examples of Load Centres Include:

- Groups of buildings which are somewhat isolated, such as housing developments or industrial parks
- Large energy users such as apartment buildings, hospitals or factories



(L) LOAD CENTRE
□ RESIDENTIAL HOME
a APARTMENT COMPLEX
c COMMERCIAL ESTABLISHMENT
I INDUSTRIAL ESTABLISHMENT
——"BOUNDARIES" OF LOAD CENTRES

FIGURE 32

At the community level, a typical load centre may encompass a number of land uses including mixed commercial, heavy industrial, medium density residential and institutional which have all been incorporated into energy load zone 1 (as shaded in Figure 33).

Once a load zone has been identified, the Planner, perhaps with the assistance of an Engineer in the Engineering Department or an outside consultant, can then proceed to determine its energy requirements. For instance, the following six measures of energy demand have been calculated for an energy load zone similar to the one shown in Figure 33.

- Annual energy consumption factor (AECF)
  - shows amount of end-use energy annually required for space heating and water heating of a building
  - local sources for values of AECF include local gas or electric utilities
  - if local values for AECF are not available, estimates can be made from the following equation:

$$AECF = (ASHF)(HDD) + AWHF$$

where:

ASHF = annual space heating factor, in BTU/(ft^2 x HDD x yr);

HDD = average annual heating degree days (e.g. 4,000 in Toronto area); and

AWHF = annual water heating factor, in BTU/(ft^2 x yr).

- Heating energy load factor (HELF)
  - shows peak hourly demand for space and water heating energy in BTU/(ft^2 hr).
  - if HELF values cannot be estimated from local data, the following equation can be used:

$$HELF = \frac{(65^{o} - WDT)(ASHF)}{24} + HWHF$$

where:

WDT = winter design temperature, in ^{o}F,

ASHF = annual space heating factor, in BTU/(ft^2 HDD yr).

HWHF = hourly water heating in BTU/(ft^2 hr); 65^o = the basic temperature used to calculate HDD; and 24 corresponds to the number of hours in the day.

- Total peak hourly energy load (TPHEL) 1.3×10^9 BTU/hr
- Subtotal annual energy use (SAEU) 2.67×10^{12} BTU
- Total annual energy use (TAEU) 2.96×10^{12} BTU
- Thermal Density
  1.07×10^{12} BTU/mi^2yr.

The above information was derived using the following table*:

* District Heating from Electric Generating Plants and Municipal Incinerators: Local Planner's Assessment Guide; W. Pferdehirt and N. Kron, Jr.; Argonne National Laboratory; (for) U.S. Dept. of Energy; Contract W-31-109-Eng-38; Nov. 1980; Page 23.

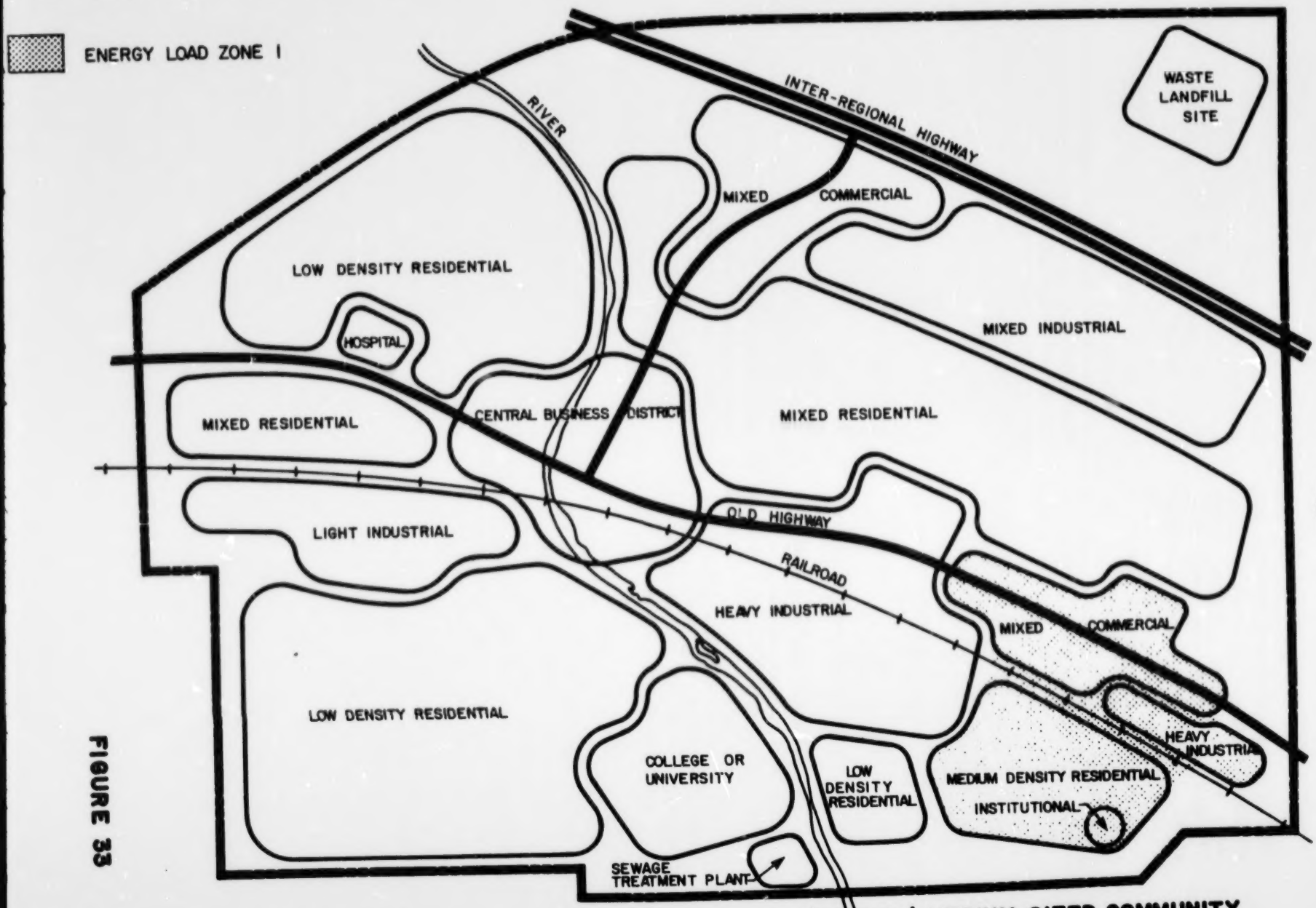
ZONE NUMBER 1

LAND AREA (mi^2) 2.5

Land Use	A Floor Space (ft^2)	B Annual Energy Consumption Factor (AECF) (BTU/ft^2.yr)	C Annual Energy Use (AEU) (BTU) (A x B)	D Hourly Energy Load Factor (HELF) (BTU/ft^2.hr)	E Peak Hourly Energy Load (PHEL) (BTU/hr) (A x D)
Medium-Density Residential	2.0×10^6	1.04×10^5	2.08×10^{11}	39.7	7.94×10^7
Commercial	2.7×10^7	5.86×10^4	1.58×10^{12}	22.4	6.05×10^8
Industrial	1.1×10^7	6.93×10^4	7.62×10^{11}	26.3	2.89×10^8
Institutional	0.2×10^7	5.86×10^4	1.17×10^{11}	22.4	4.48×10^7

Subtotal Annual Energy Use SAEU) =	2.67×10^{12}	Subtotal Peak Hourly Energy Load (SPHEL) =	1.02×10^9
Transmission And Distribution Losses (11% of (SAEU) =	0.29×10^{12}	Transmission and Distribution Losses (11% of SPHEL)=	0.11×10^9
Total Annual Energy Use (TAEU) =	2.96×10^{12}	Total Peak Hourly Energy Load (TPHEL) =	1.13×10^9

$$\text{Thermal Density} = \frac{\text{TAEU}}{\text{Land Area}} = 1.07 \times 10^{12} \ \frac{\text{BTU}}{mi^2.yr}$$



'TYPICAL' MEDIUM SIZED COMMUNITY

FIGURE 33

From this information, a Planner can identify the energy loads carried by the various areas within the community. The Planner can then select the energy supply systems which best satisfy these loads.

For example, the waste heat generated by the industrial plants in energy load Zone 1 (identified in Figure 33), can be used to satisfy some of the energy demands of the nearby residential and commercial sectors. Some of the advantages of such an arrangement would include: short transmission distance, reduced dependency on centralized systems, and the effective utilization of the industry's complete energy output.

ADMINISTRATIVE AND JURISDICTIONAL ASPECTS OF ALTERNATIVE ENERGY TECHNOLOGY AND SYSTEMS

Organization

The larger and more complex the system, the more likely it is to involve the participation of many diverse groups. The system could impinge on all levels of government, many private organizations, and subscribers themselves. The administrative and jurisdictional relationships may or may not constitute barriers to the design, construction, operation and maintenance of the new energy supply network.

A refuse-fired system for example, potentially creates a conflict between the disposal of garbage and the generation and provision of useful heat. In Toronto, Metropolitan Toronto is responsible for garbage disposal, however, the distribution of heat from the plant, (i.e. district heating system), is the responsibility of the City of Toronto.

In summary, a district heating system could be expected to be subject to all the related planning and operational controls within the Provincial Government and Regional Government, local or Municipal Government(s) affected and various special purpose bodies of these different levels of government (not to mention private interests such as private utility).

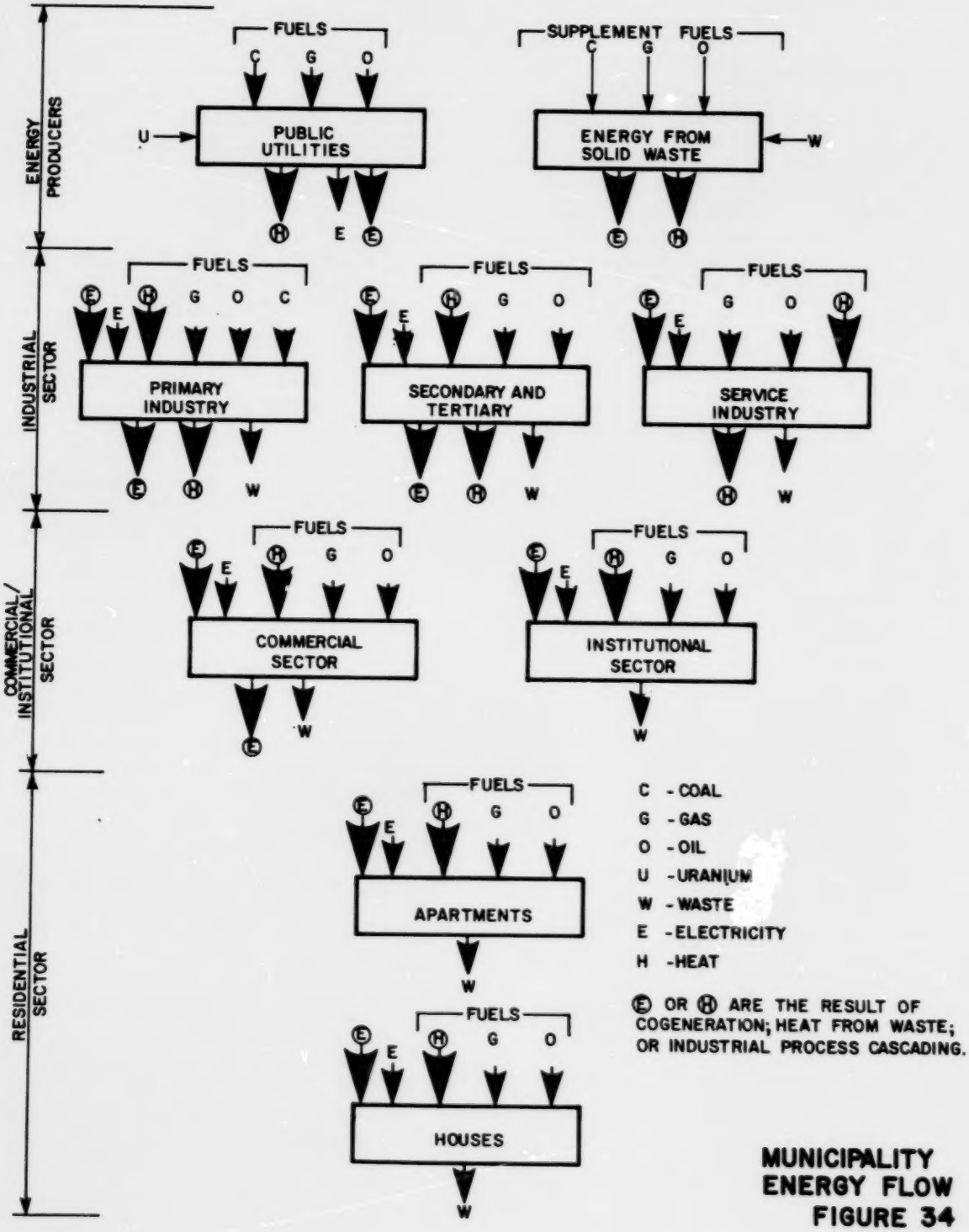
However, perhaps above all else, a strong working relationship between the organization responsible for the 'generation of energy' and that responsible for the 'distribution of energy', is absolutely essential. A local Planner assuming an advocacy role, within the context of other planning considerations, could be instrumental in facilitating this arrangement.

Municipal Energy Flow

It is important that the Planner has a good understanding of the general flow of energy associated with the primary delivery facilities and land use components, in order to appreciate the numerous in-flow and out-flow possibilities (see Figure 34).

In maximizing the effectiveness of alternate energy systems, the energy outputs, such as heat and electricity, of one sector (e.g. industrial) become the energy inputs of another sector (e.g. commercial or residential). The larger arrows of Figure 34 indicate some of the possible arrangements.

This information can be further described in terms of the possible overall integration of the primary suppliers and receivers according to energy use. For example, a committee could be organized representing the interests of all parties involved in the generation and distribution of energy. The aim of such a committee would be to develop an energy management study in order to facilitate the utilization of alternate energy systems.



MUNICIPALITY ENERGY FLOW FIGURE 34

Illustrating the foregoing integration (see Figure 35) demonstrates that the effective utilization of alternative energy technologies and systems dramatically increases energy use possibilities throughout the entire community.

One can also better appreciate the potentially complex and highly sensitive nature of administration and jurisdictional aspects of integrated energy systems from an understanding of the above information. For example, the rights to energy ownership, management and distribution become more involved when a new agent such as the industrial sector is allowed to participate.

Market

Potential subscribers in existing developed areas, who are already being served by a competing supplier of heat energy, (e.g. natural gas by a private utility), may have to be induced to switch to a district heating system. Certainly, legislating such an action is neither possible under current enabling law nor is it likely ever to be desirable, let alone enabled under new laws.

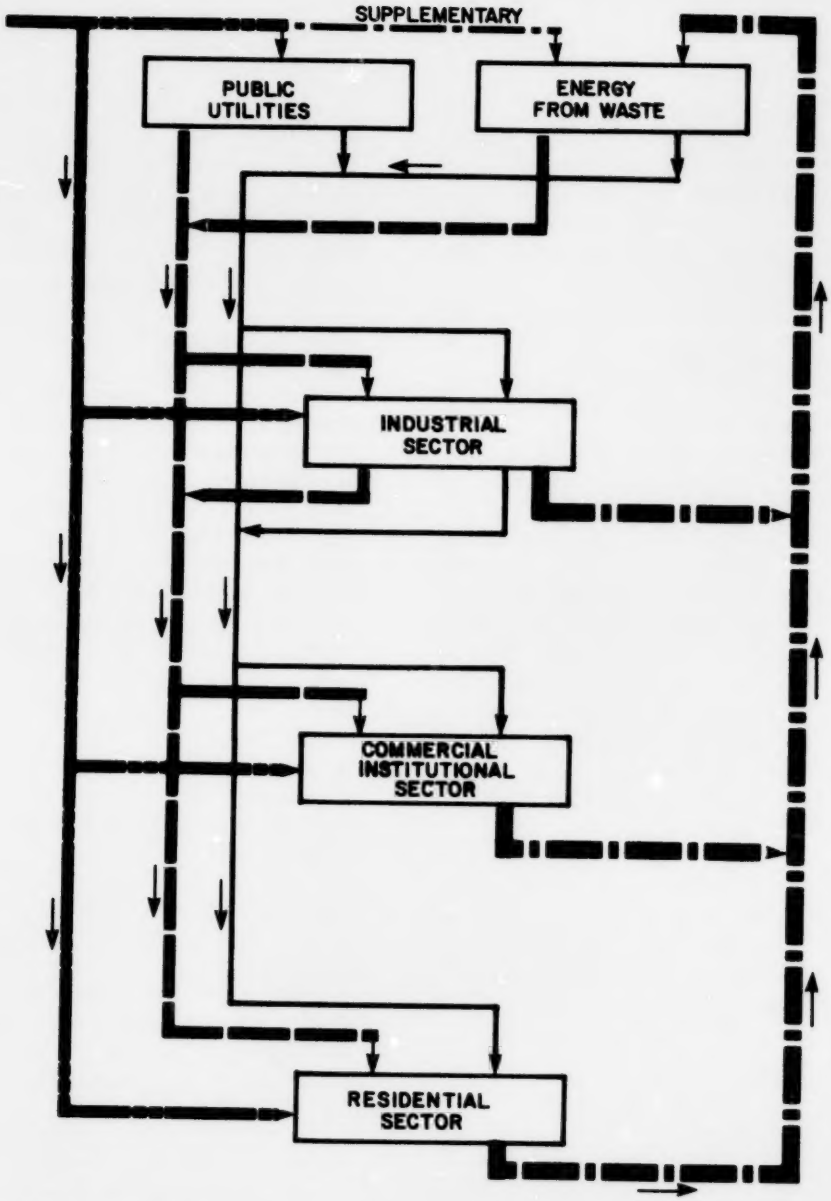
Much of the existing building stock is currently being retro-fitted to conserve energy being generated by conventional energy systems.

More buildings will undergo this kind of retro-fit before energy supplied from relatively efficient alternative systems, (i.e. co-generation, cascade energy, waste or biomass-fired), is instituted or even seriously proposed in a given area.

In any event, energy loads for existing structures are changing as a result of internal retro-fit measures and future (stable) energy loads are difficult to gauge. Cost-benefit analysis of alternative energy systems are much more difficult as a result.

New development on the other hand, can be designed and engineered to facilitate the use of alternative energy supply systems and technology. Integrated and mixed use developments are good examples of land use arrangements suited to alternate energy systems. Such land uses tend to have higher densities and may include commercial, institutional or light industrial sectors. In such cases, the waste heat generated by the industrial sector can be used to satisfy some of the area's energy requirements. As well, integrated and mixed use developments represent excellent loads for on-site total energy power plants encompassing a district heating system.

Furthermore, there is not likely to be any difficulty in establishing necessary rights-of-way for district heating transmission pipelines in new areas. Quite the opposite is the case in developed areas where both jurisdiction and economics could pose formidable problems.



POTENTIAL MUNICIPALITY ENERGY FLOW SHEET · FIGURE 35

PLANNING PRACTICE

Introduction

The basic land use planning principles, identified below, have usually provided the basis for planning decisions or recommendations; only their relative impact or degree of acceptability to the public has compromised their success.

- contiguous and centralized development versus sprawl and strip development
- well designed medium and high density versus low density residential development
- close proximity between personal residence and place of business/school or other routine services required outside the home
- pedestrian/cycle transportation preferred over motorized transportation for daily or routine functions
- public transit versus private motorized transportation
- foodlands preservation versus unnecessary or 'reckless' urban development of foodlands

Effective conservation of energy is inherent in each of the basic land use planning principles mentioned above. Basic underlying principles of energy conservation are:

- utilization of efficient energy supply systems versus energy supply systems which have relatively high production or transmission losses
- close proximity between source and consumer of energy versus extensive distance separation
- reliance upon renewable energy forms versus non-renewable forms of energy to extent practicable and feasible

Thus the effective conservation of energy, and good land use planning decisions are predicated upon highly compatible principles.

Mixed use developments, integrated land uses and medium and high density residential developments are the basic target land use planning components for the successful incorporation of alternative energy supply technology and systems; as well as being the primary physical components of successful urban planning and development.

Policies to encourage the development of higher residential densities, mixed use or integrated use developments and multi-functional buildings in central business districts and suburban 'town centres', are being embodied in an increasing number of Official Plans.

The suburban "Town Centre" or "Multi-Functional Service Node", which often incorporates school and church 'campuses' in addition to business and commercial, and other institutional uses, is an excellent example of contemporary mixed or integrated use developments.

Incentives to both the building and development industry and the consumer (market) are required however, to realize some of the land use forms being prescribed above (particularly higher density forms of residential development). These incentives could include:

- more flexible zoning standards (e.g. trading off some aspects of aesthetic control for better functional control)
- bonus-zoning techniques (e.g. density bonuses)
- mandatory energy consumption (energy load) disclosures by builders (i.e. builders are obliged to inform consumers about future quantities and costs of energy associated with their product...like an EPA rating of 48 miles to the gallon!)

It is important to note that advanced technology, such as various forms of pollution control, and improved buffering techniques (i.e. thoughtful landscaping and building design) have combined to significantly reduce conflict between different land uses which were, heretofore, incompatible in close proximity to each other.

It is now being recognized that many types of industrial and commercial operations can co-exist in harmony with residential uses (See figure 36).

These are enormously important factors since they mean that at least some industries that cascade (heat) energy or central power plants (i.e. either co-generation or refuse-fired) can be successfully integrated into or located abutting a predominately residential area; thereby enhancing the chances for application of large-scale district heating systems.

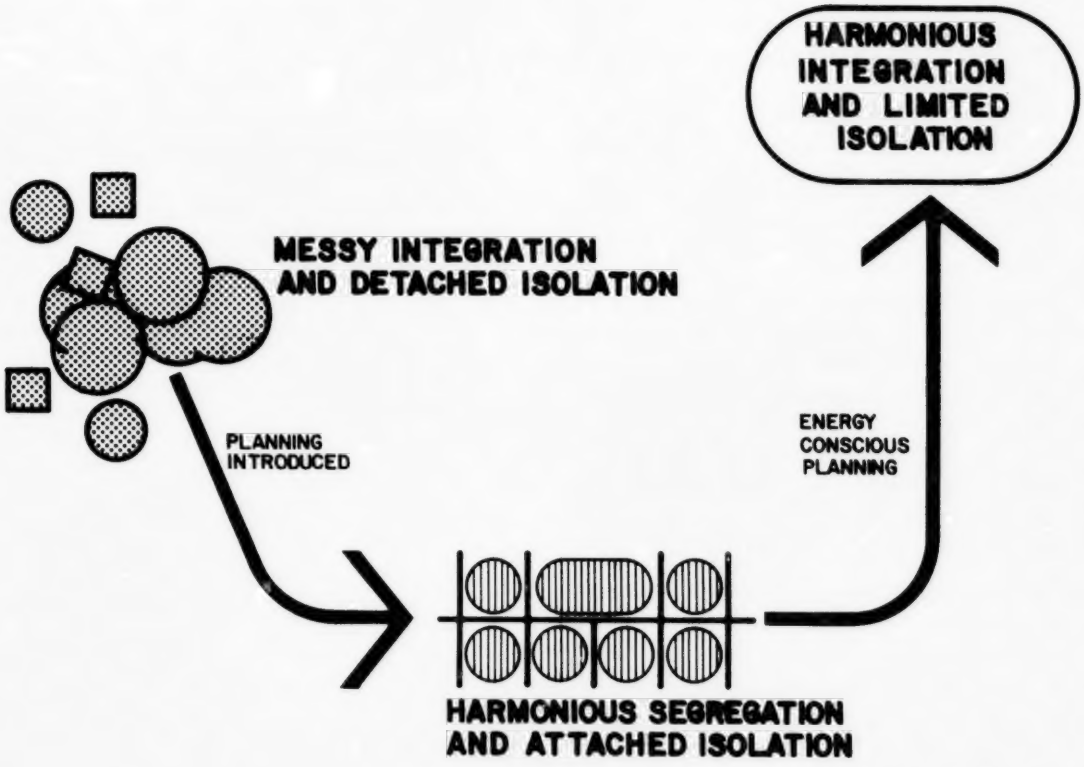

HARMONIOUS INTEGRATION AND LIMITED ISOLATION
MESSY INTEGRATION AND DETACHED ISOLATION
PLANNING INTRODUCED
ENERGY CONSCIOUS PLANNING
HARMONIOUS SEGREGATION AND ATTACHED ISOLATION

FIGURE 36

Implementation

There are three basic components of general planning practice:

i) policies;
ii) regulations; and
iii) advocacy measures (including guidelines)

Policies

Formulating Official Plan policies, or municipal policies otherwise established by resolution of Council, is the first step in the usual incremental implementation process.

"Policy Report No. 16: Energy Conservation" associated with the City of Edmonton General Municipal Plan (G.M.P.) dated July 7, 1981, defines a proposed related City G.M.P. policy, (quoted below) which serves as one example general provision for potential use by other local governments:

> "The City will support (or encourage)* the development of thermal energy distribution networks from its centralized power plant systems or similar (local, institutional, commercial or industrial cascade) sources to provide efficiently generated, lower cost energy to Edmonton (local) residents."
>
> *brackets indicate author's preferred wording

The supporting City of Edmonton policy report alludes to the positive results of a preliminary local feasibility study which "concluded that the development of a district heating system (in downtown Edmonton) would present few insurmountable engineering or construction problems and that the district heating system would be financially successful".

Reference was also made in the Edmonton report, as further information to support the above proposed policy, that district heating systems have been used successfully for many years throughout Europe and more recently, in both Vancouver and Toronto.

The City of Edmonton report correctly identified the real potential opportunities for district heating systems both in areas with significantly lower heat load densities such as inner City and other older neighbourhoods within reasonable distance from existing (or future) central power (or thermal) generating plants; and, in conjunction with suburban mixed or integrated use areas, (e.g. Town Centre or community service node concepts).

In addition to a 'general provision' policy such as the one illustrated and supported above, municipal Official Plans could also (eventually) be modified so that specific land use policy sections are supportive and more specific.

The industrial policy section for example could contain policies that address the location of specific types of potential energy cascading industrial uses i) within the community; ii) relative to other thermal generating facilities; iii) within industrially designated areas (or areas designated 'integrated use'); and iv) relative to identified or projected thermal load density zones within the community.

Policy statements related to right-of-way requirements associated with future district heating systems as well as policies related to the administration and jurisdiction of central thermal plants and systems could be incorporated into the 'public works' section of the Official Plan; this includes policies related to the potential utilization of existing rights-of-way or the acquisition of new rights-of-way in existing developed areas.

Policies to encourage well designed medium and high density residential developments, particularly in areas proximate to existing or potential central sources of thermal energy, could be incorporated into the Residential section of the Official Plan.

Regulations

Existing planning legislation provides ample opportunity to deal effectively with the energy issue.

In the case of alternative energy supply technologies and systems, Site Plan Approval, enabled under Section 35a. of the Planning Act (Ontario), contains all the necessary 'conditions' pertaining to the physical aspects of the system (e.g. 35a. (6) (a) 8. which deals with the conveyance of servicing easements to the municipality). Other more conventional statutes in The Planning Act and related Acts, provide for attention to development densities, location and siting of land uses, pollution control and so on.

The issue does not so much rely on land use regulations, but, as stated earlier, on administrative and jurisdictional aspects of 'program delivery'.

It is important to realize that a municipality may, either directly or through its public utilities Commission, generate, purchase or distribute to its residents several forms of energy.

- "Municip-lities are empowered by s.18 of The Public Utilities Act, R.S.O. 1970, c.390, to "manufacture, procure, produce and supply" for its own use and the use of municipal residents such public utilities as electricity, how water, natural gas and steam. Towns and cities which purchase their electricity from Ontario Hydro are obliged to entrust their electrical works to the management and control of a hydro electric or public utilities commission (s.40 (3), The Public Utilities Act); other utilities may be so entrusted if the municipality wishes."

Furthermore, private companies supplying energy to public utilities require a franchise granted by the municipality which includes conditions of approval, (i.e. potentially including review period(s), minimum quantities of energy supplied, etc.)

Advocacy Measures

The most challenging and perhaps, vital action that the Planner will undertake, lies within the realm of "advocacy measures".

An initial policy report to Council, in addition to establishing the general case and recommending new policy and planning objectives, would recommend further actions.

If the policy report had not been preceded by local research, then "further action" could refer to:

- identification of existing central power plant facilities, or operations that could be converted to the magnitude of a 'central power plant' (see Figure No. 29).

- identification of existing energy load zones within the municipality, noting their location to the facilities identified above.

- examination of existing Secondary or Tertiary Plans to identify opportunities for the incorporation of development guidelines geared toward the potential use of alternative energy technologies and systems.

- survey of local industries to determine their energy load requirements, in terms of both quantity and quality, (e.g. high or low pressure steam); as well as those industries that, if given the opportunity to sell waste energy, would convert their mechanical plant to a "new alternative technology and system".

- determine the policies of the local utilities and/or their parent organization regarding alternative energy technologies and systems

- identify all potential assistance programs and match them to local opportunities.

The above information would enable the Planner to prepare a strategy report for endorsation by Council in order to obtain a mandate to proceed.

The final phase of implementation would initially involve the following meetings listed in order of priority:

- meeting(s) with local utility(ies) to discuss ideas about complementary or joint actions (note: this should involve local or regional Industrial Commissioner or Industrial Development Officer as well as local school board representatives).

- meeting with local Chamber of Commerce.

- general public meetings.

The Planner should always be looking for a 'seed project', or the most likely opportunity to be successful, and concentrate efforts on that particular case.

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